

**Ozone – What is the chemistry of ozone  
formation in the study region?  
What are the exposure patterns?**

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# Ozone is formed in the atmosphere:

- Precursor pollutants react to form ozone
  - oxides of nitrogen (NO<sub>x</sub>)
  - reactive organic gases (ROG)
- Ozone formation is complex because
  - nonlinear response of ozone to emissions reductions
  - spatial and temporal variability

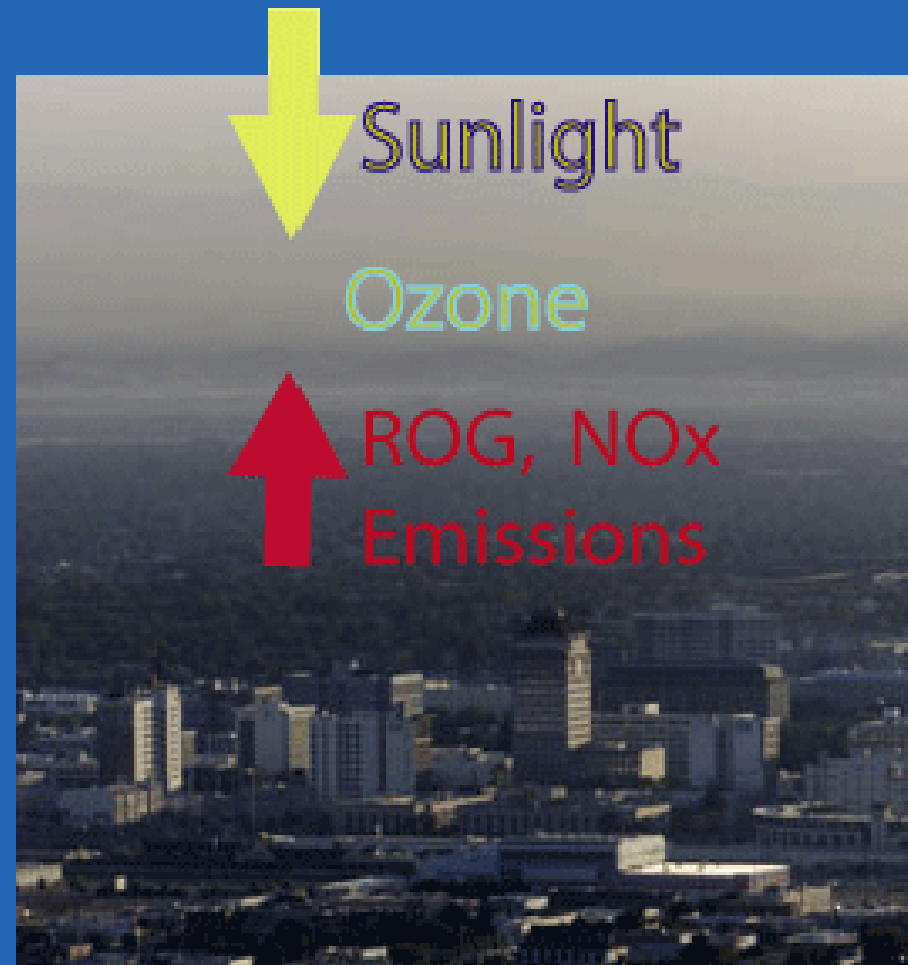


Photo: Mark Crosse / The Fresno Bee, 2002

# Precursor Emission Sources

- NO<sub>x</sub>: cars, trucks, power generation, industry



- ROG: cars, agricultural activities, off-road vehicles, industry, solvent evaporation, natural sources

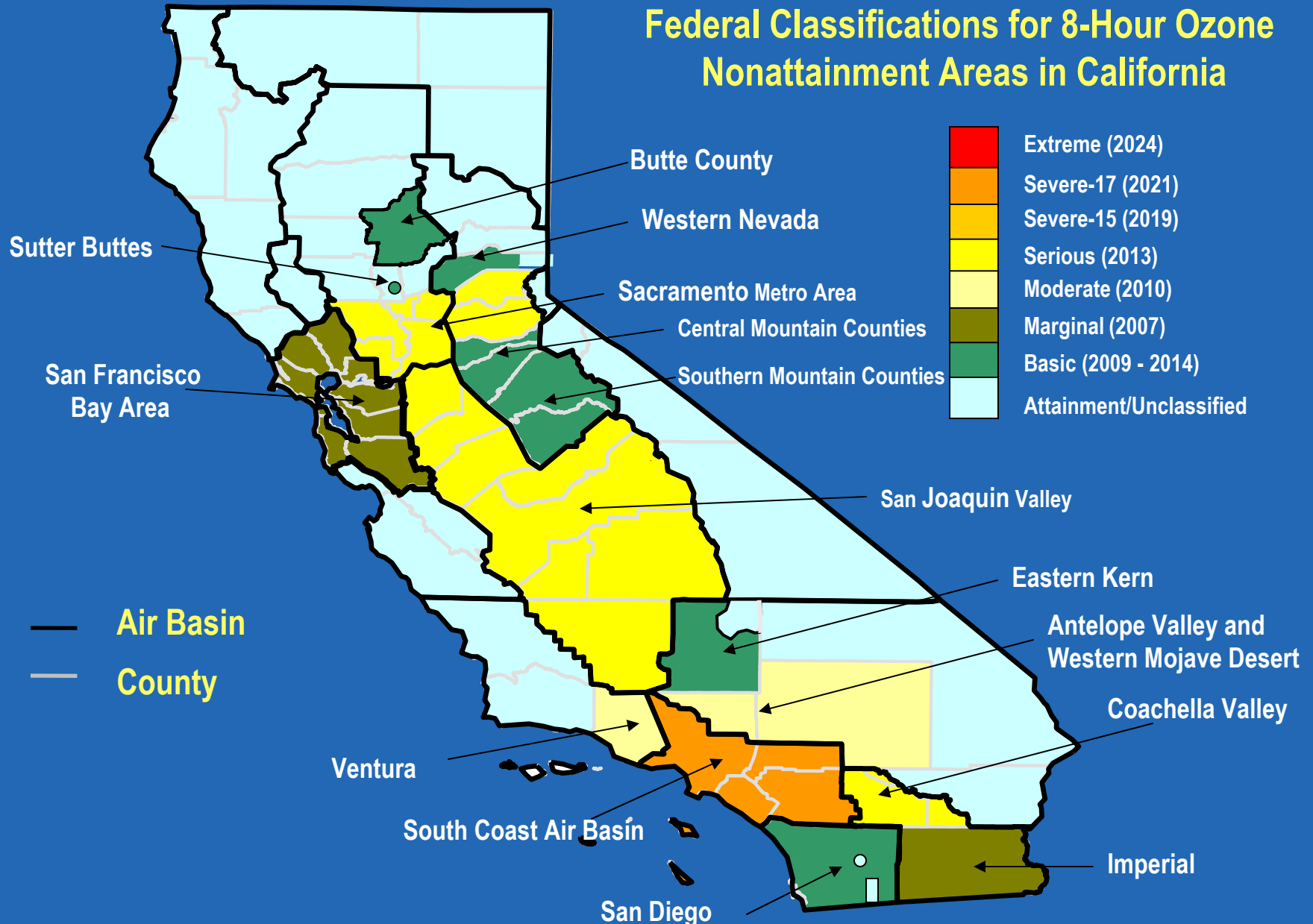


# 8-hour Ozone Standard

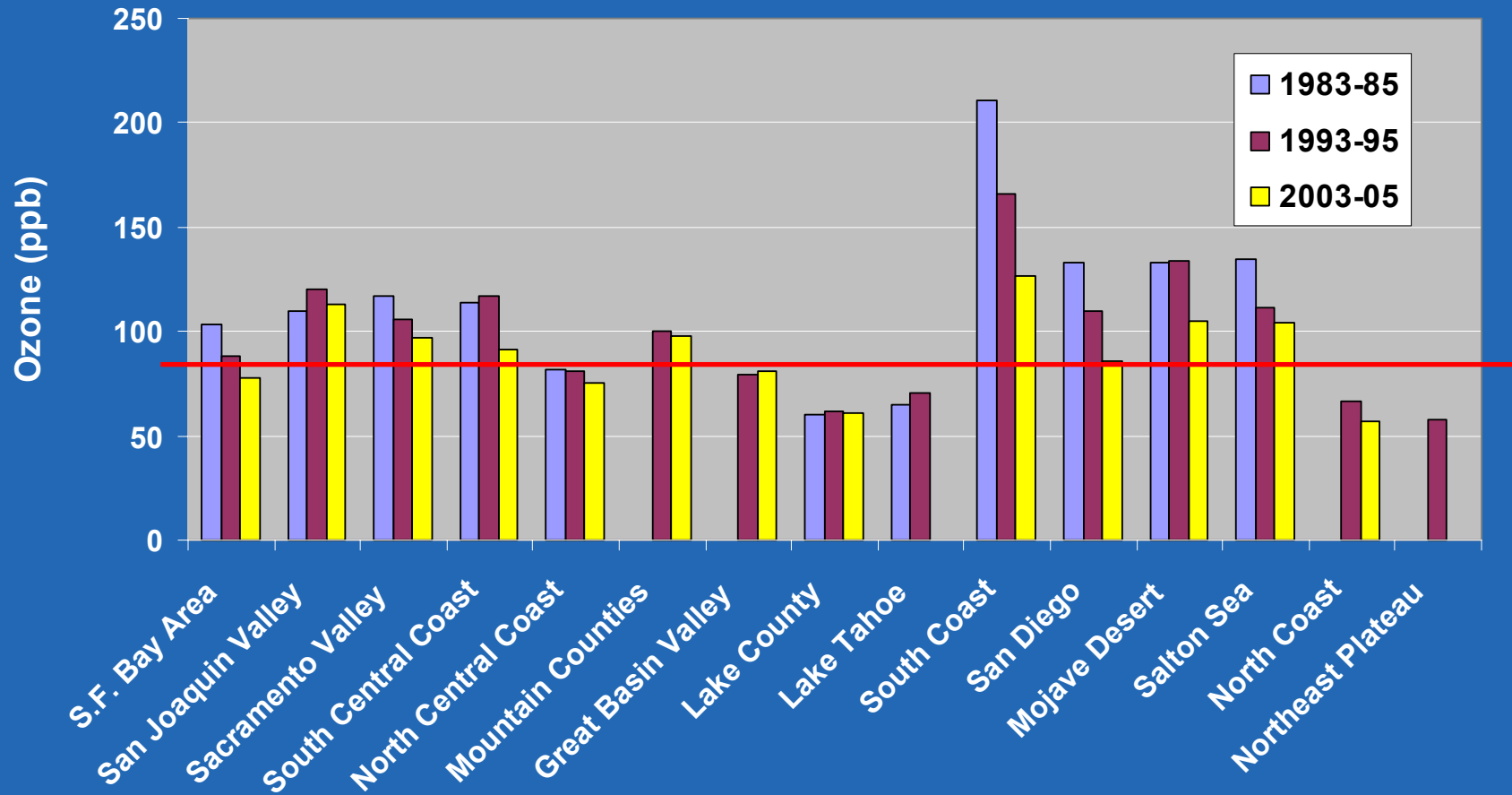
- U.S. Environmental Protection Agency set ozone standard to 0.08 parts per million (ppm)
- 8-hour averaging period
- Based on more than 3,000 studies of health and ecological effects of ozone
- Many studies show that health effects occur at levels lower than the previous 1-hour standard
- Exposure times longer than one hour are of concern

# 8-hour Designations

## Federal Classifications for 8-Hour Ozone Nonattainment Areas in California

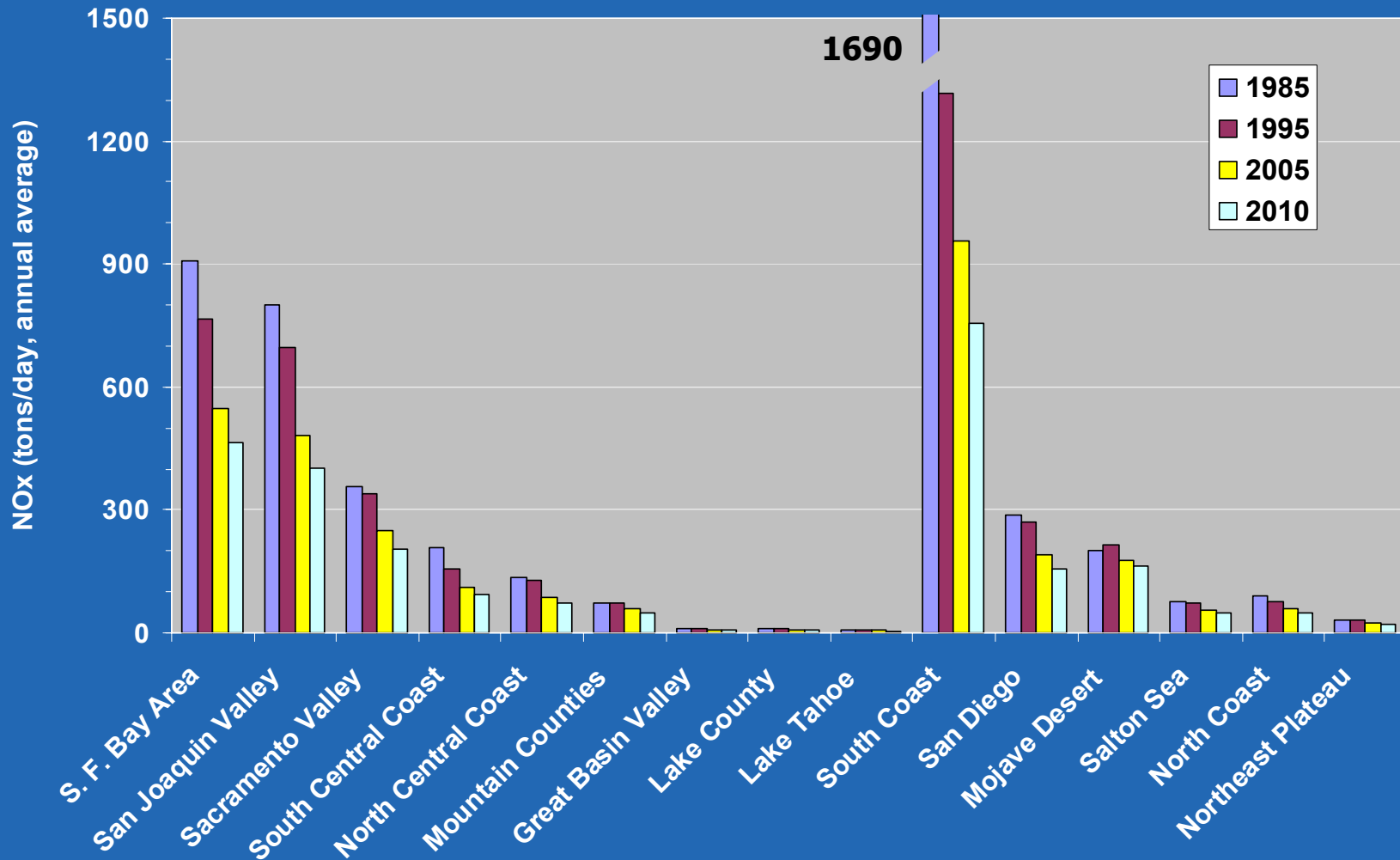


# Ozone Trends (8-hour design values)



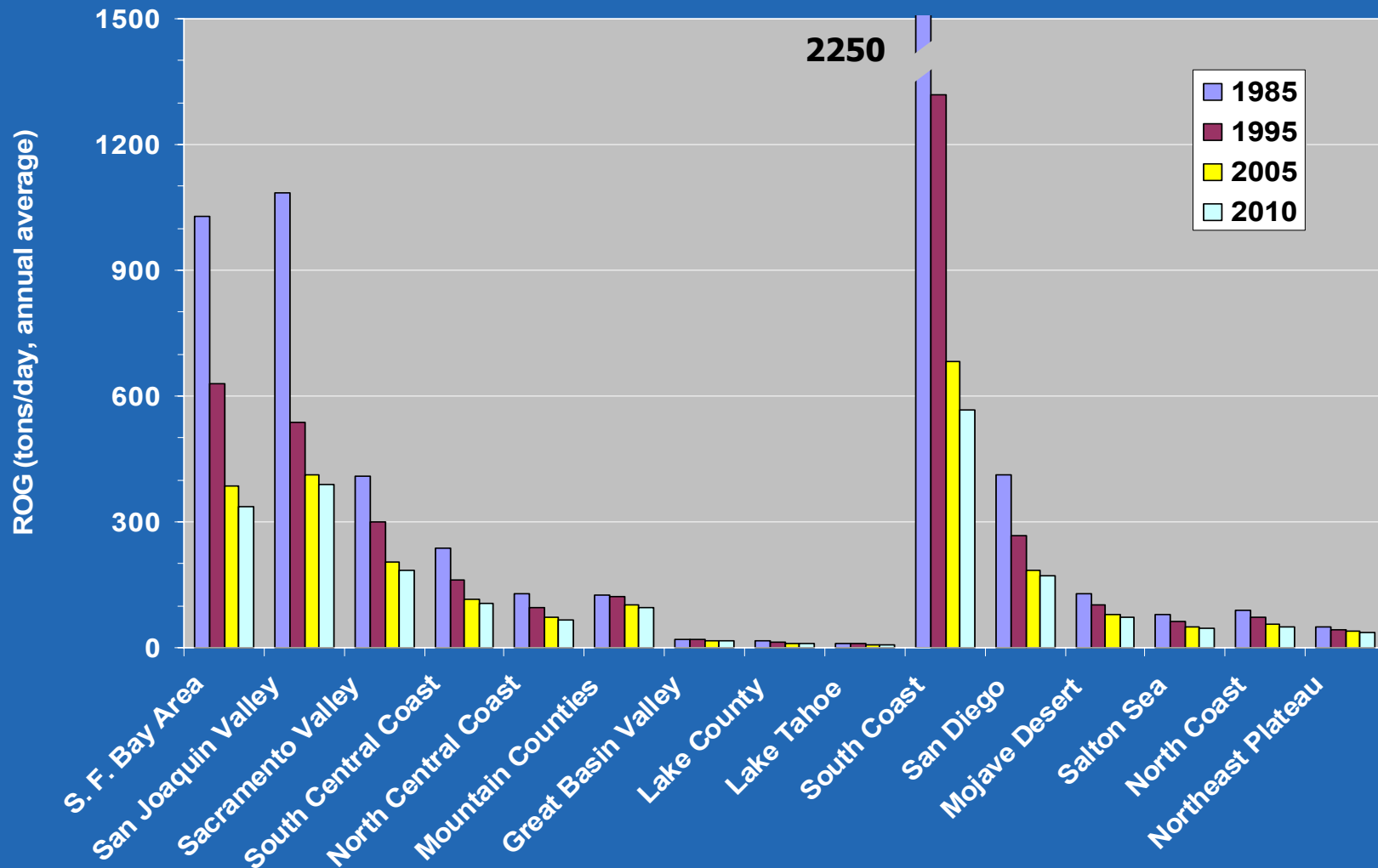
# Emission Trends – NO<sub>x</sub>

(tons/day)



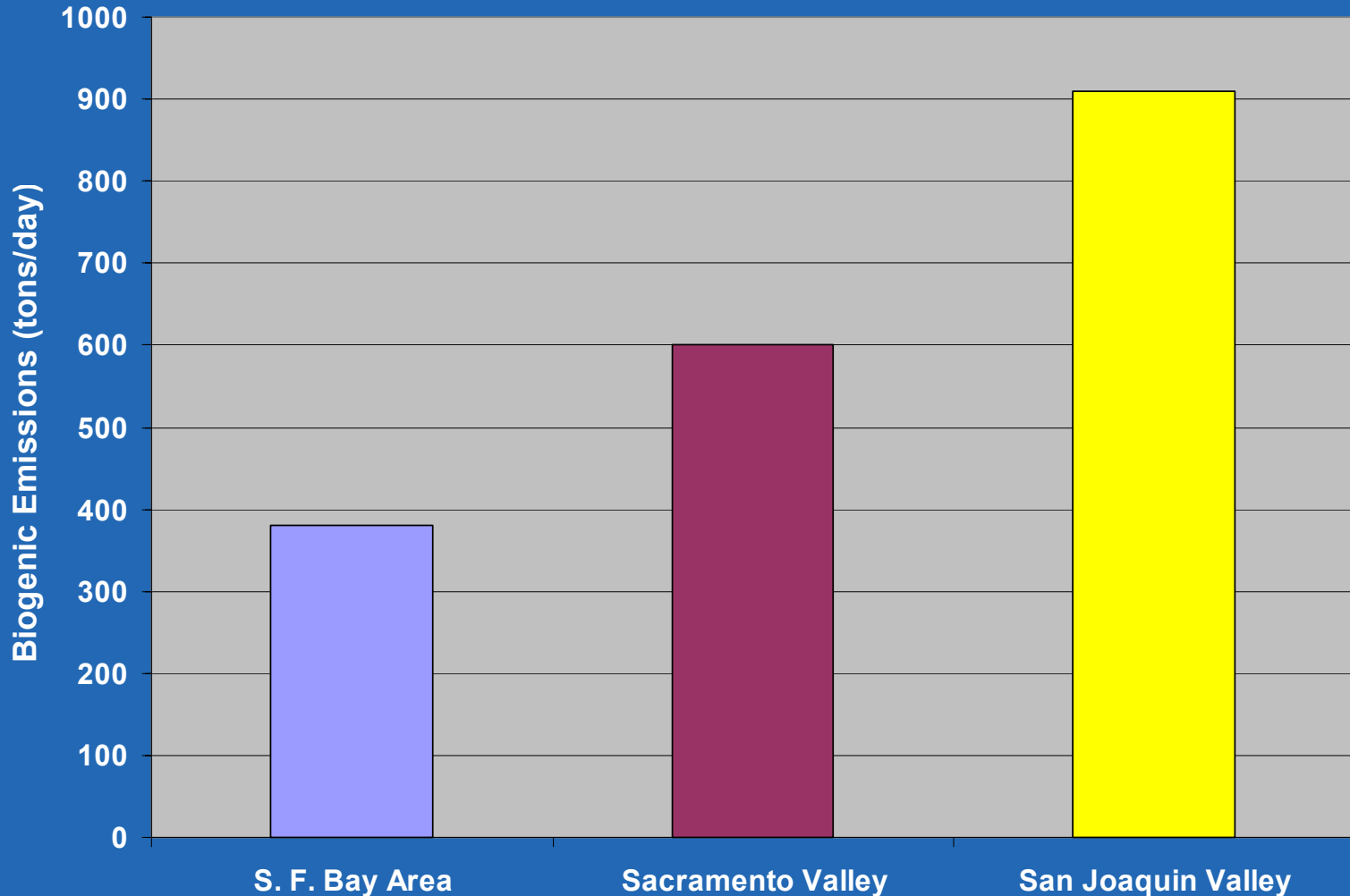
# Emission Trends – ROG

## Anthropogenic Only (tons/day)

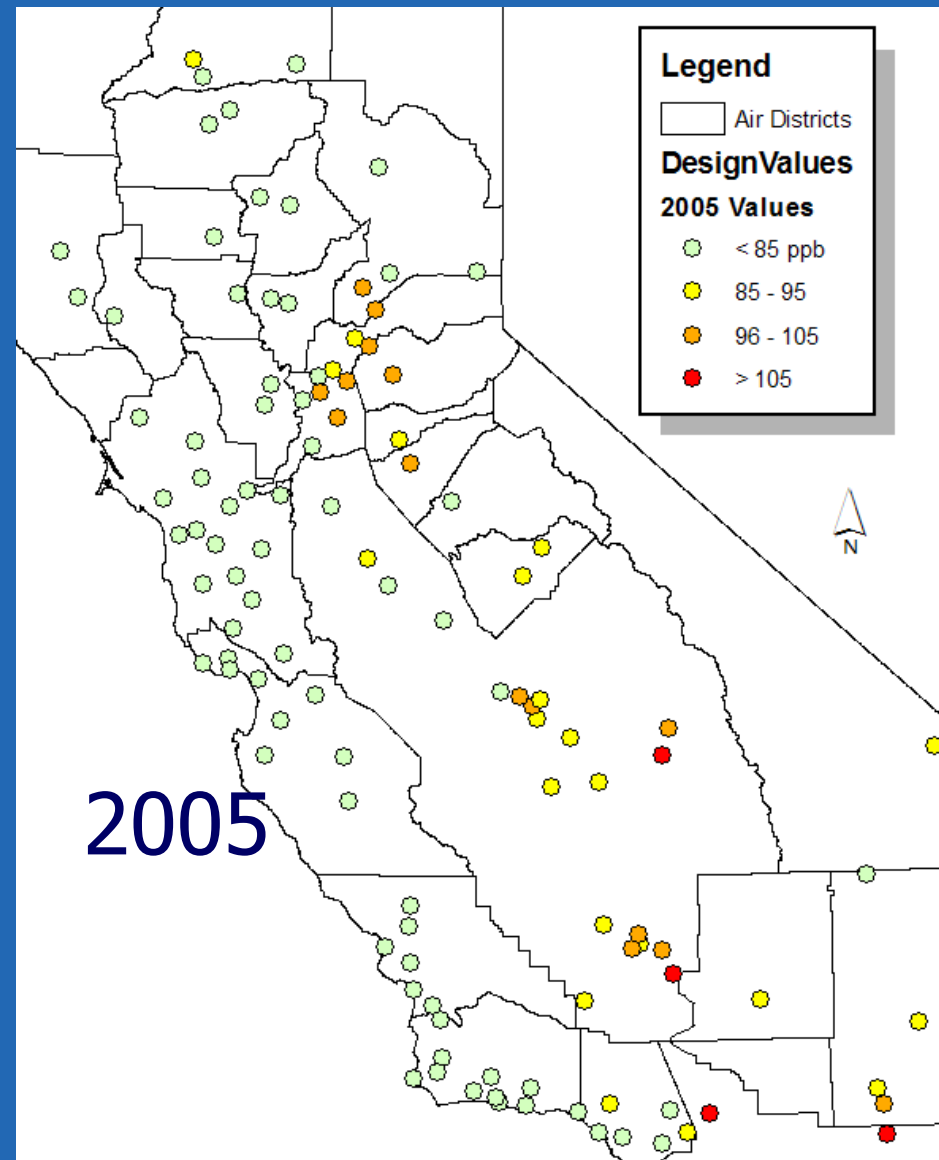
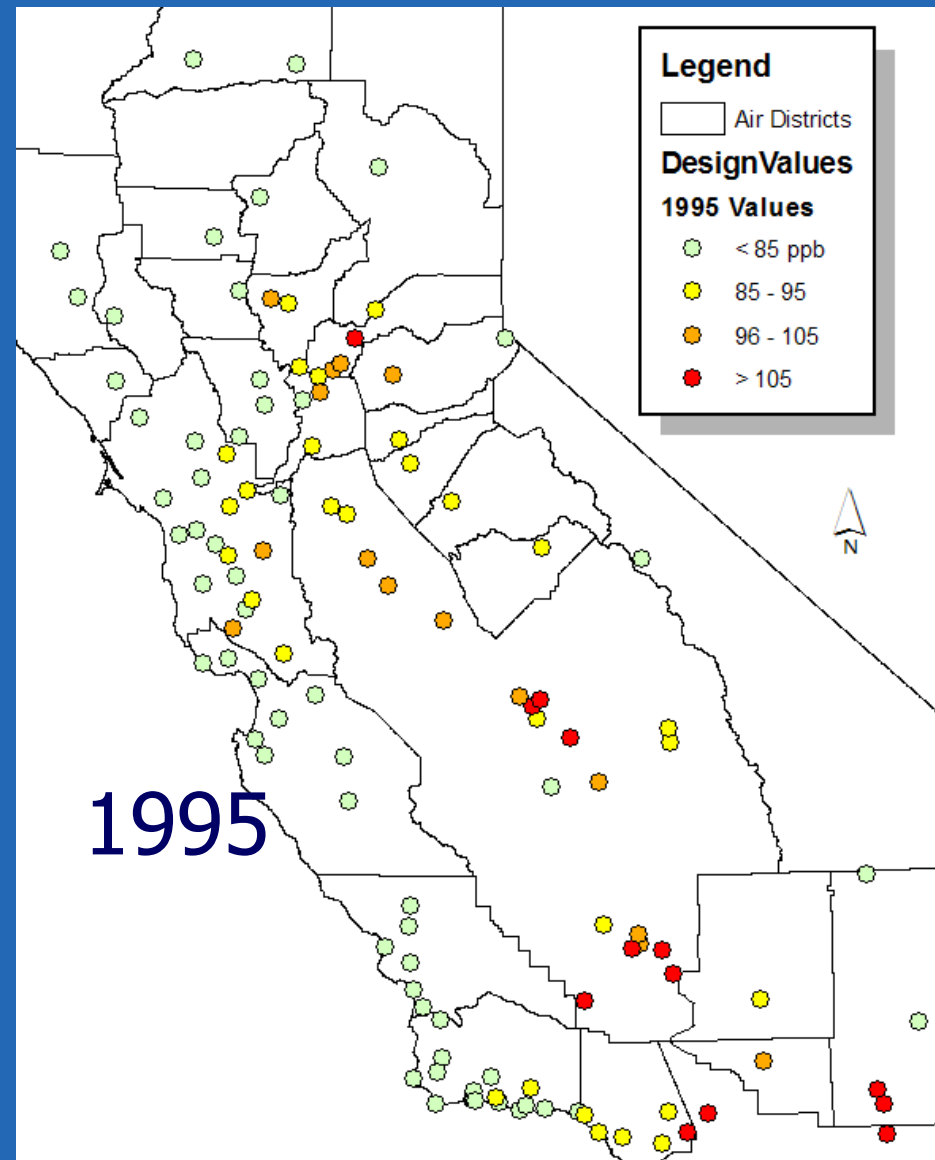




# Biogenic Emission – ROG (tons/day)



# High Ozone Spatial Extent Reduced



# Central California Ozone Study

## Purpose & Study Design

- Meet regulatory modeling requirements for 8-hour ozone standard
- Determine relative benefits of ROG and NO<sub>x</sub> emission controls
- Understand importance of transported pollutants

# CCOS Components

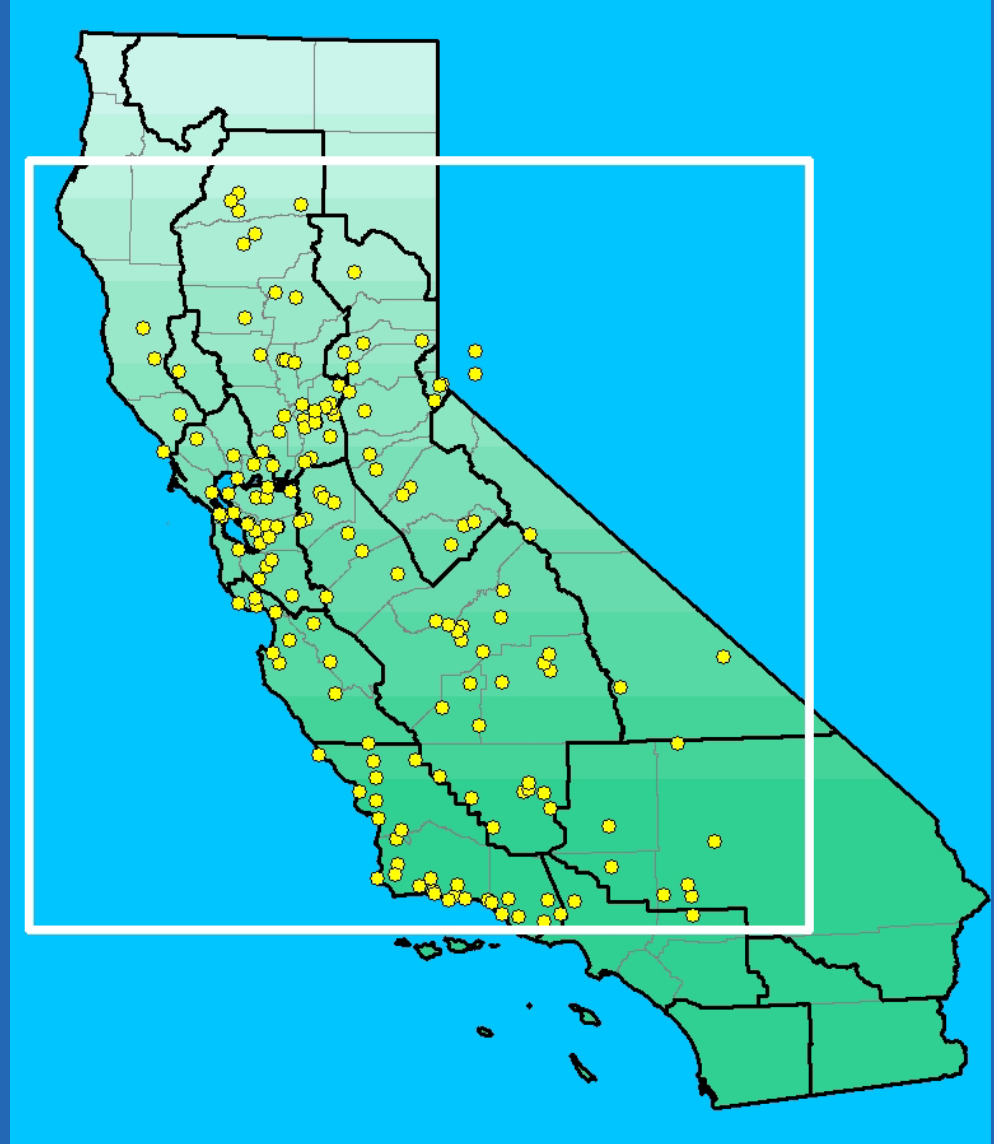
- Planning
  - 1997- 99
  - Major effort, 28 research groups
- Main Field Study: Summer 2000
- Emissions Inventory Improvements
- Analysis of Field Study Data
- Computer Modeling

# CCOS Measurements

- Supplemental Surface Monitoring:
  - Pollutants, meteorological measurements
  - Research sites
  - Speciated ROG, solar radiation, sunlight absorption & scattering
- Upper-Air Network:
  - Ozone, winds, temperature
- Aircraft Flights
- Remote Sensing, On-road Mobile

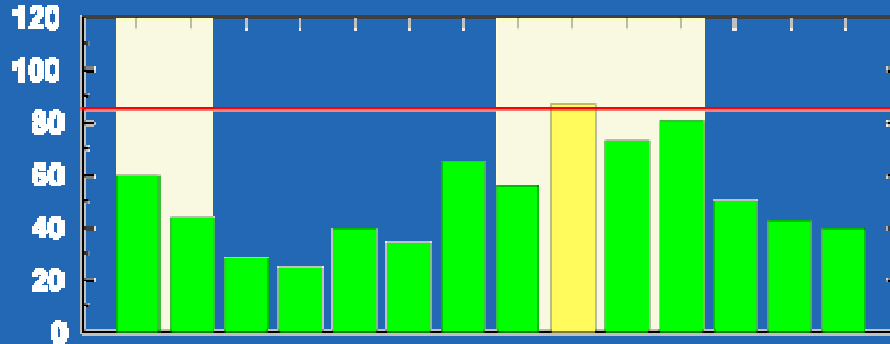
# CCOS Air Quality Monitoring Stations

- Routine monitoring stations
- Supplemental monitoring stations
- Research monitoring stations
- Similar network for meteorological monitoring

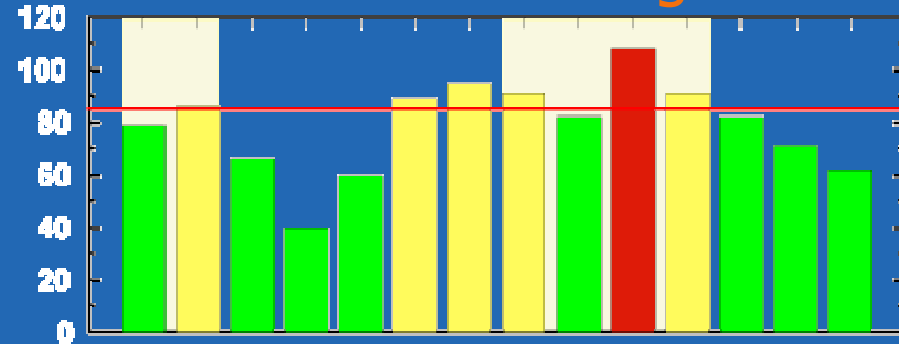


# Ozone Epiisode Timing

Livermore

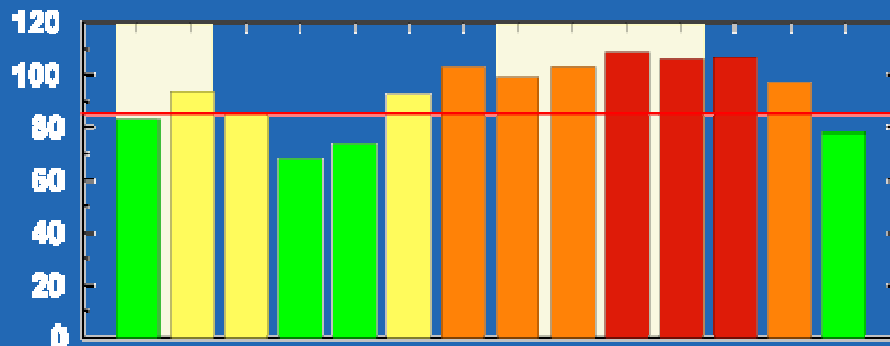


Sloughhouse

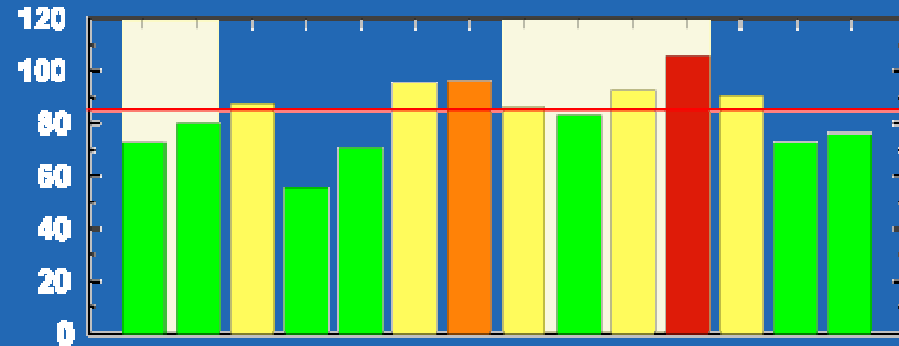


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Fresno



Bakersfield

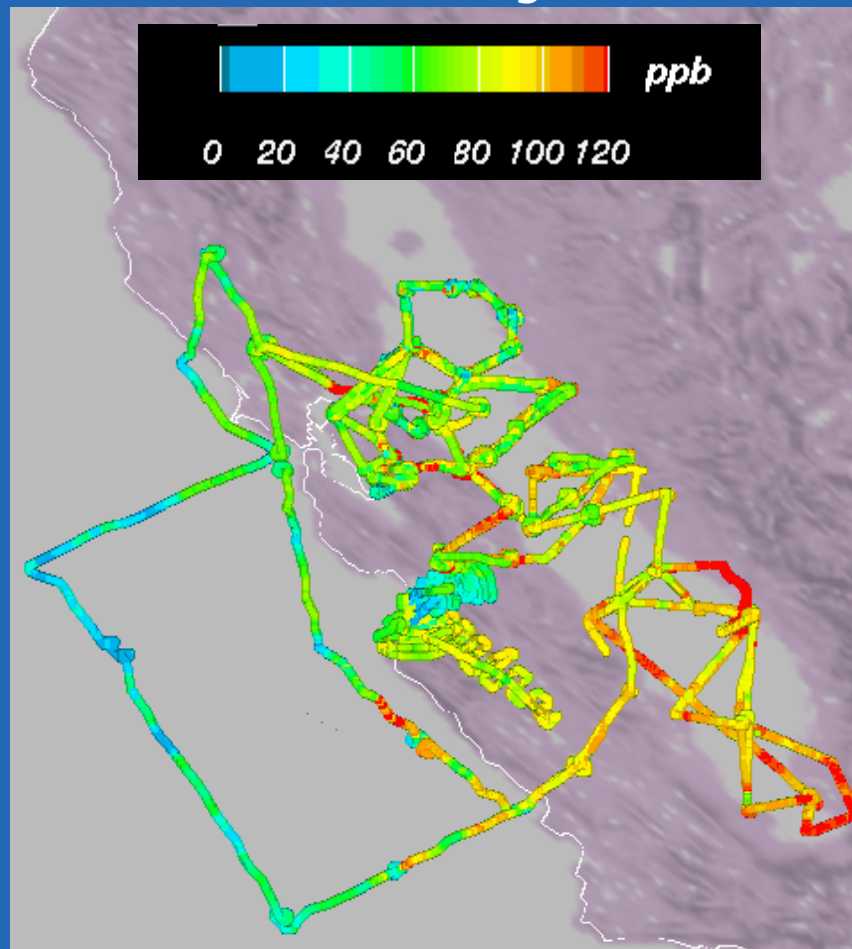


Intensive Operation Periods highlighted with white background

# Ozone – Aloft Measurements

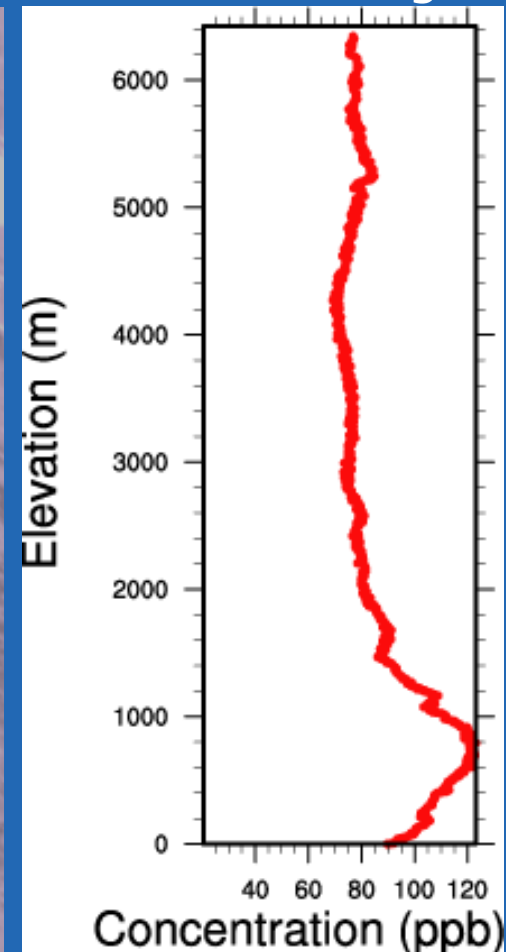
- Understand upper-level pollutant transport
- Ozone & precursors entering study region
- Special-study tracking smoke plumes

Aircraft flights



Jul.-Aug. 2000 intensive

Ozone soundings



Parlier site, 6 p.m.  
Aug. 1, 2000

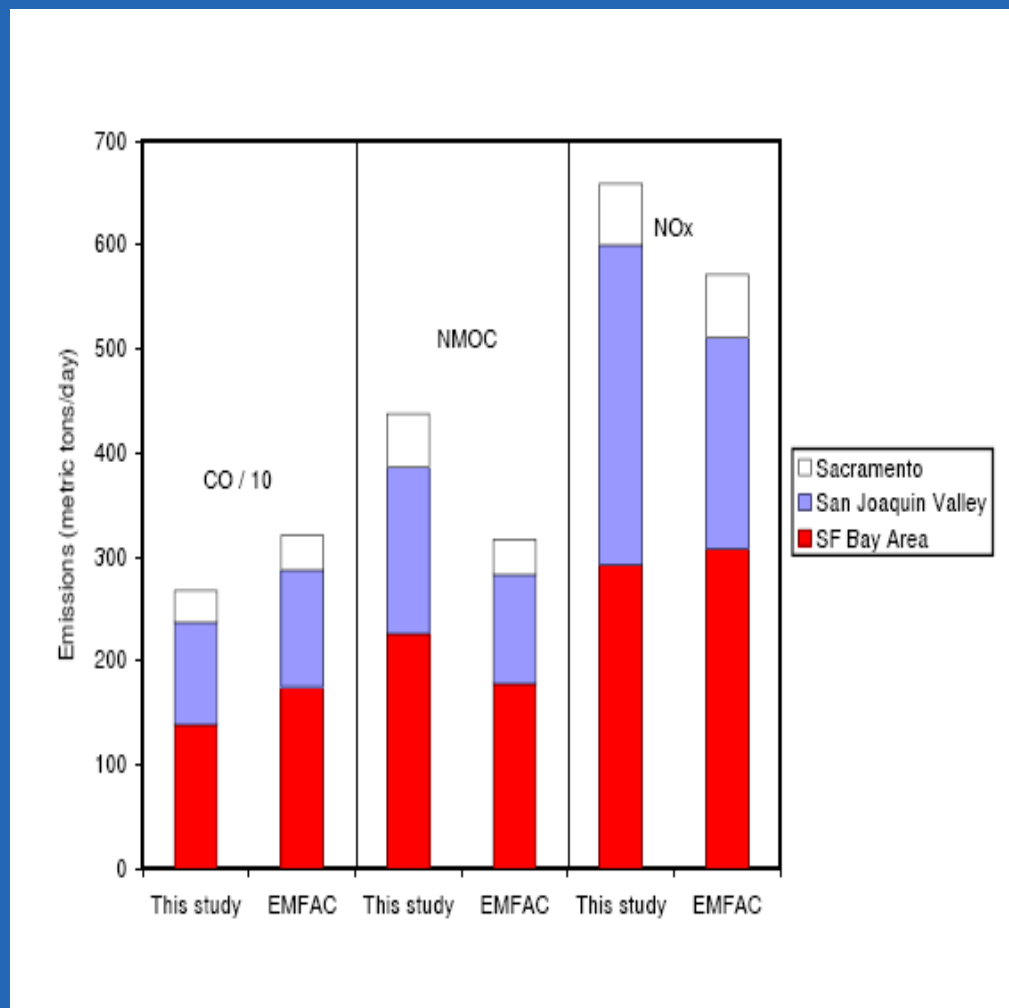


# CCOS Emissions & Evaluation Projects

- Emission Inventory Improvements:
  - Transportation network & activity update
  - Complete spatial data & micro-inventory
  - Reanalyzed selected speciation profiles
  - Biogenic and wildfire emissions estimated
- Emissions inventory assistance provided to small Districts within the study domain
- Assessed on-road mobile inventory with monitoring data & remote sensing data

# On-Road Mobile Emissions Inventory Assessment

- On-road motor vehicle ROG emissions reduced by half from 1990 to 2000
- NOx shows little change in the same period
- ROG may be underestimated
- Diesel NOx underestimated in San Joaquin Valley



# CCOS Findings

- Extent of study domain reflects regional nature of ozone problem
- Classification of types of ozone days
- High ozone values aloft
- Ozone and precursor estimates along boundary
- On-road mobile estimates from light-duty cars and trucks well represented and emissions reducing

# CCOS Findings (continued)

- On-road diesel emissions not as well characterized, emissions increasing
- Highest “transport days” typically not the highest ozone days
- Highest ozone shifting downwind of urban locations
- Collaboration, cooperation among Districts & Air Resources Board
- Data set for modeling and analysis

